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SYSTEM AND METHODS FOR REAL-TIME PRINTING

Inventors:

**Samuel M. Lester
Jimmy Sfaelos**

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SYSTEM AND METHODS FOR REAL-TIME PRINTING

TECHNICAL FIELD

The present disclosure relates to document printing, and more particularly,
5 to pre-processing document information during the generation of a document so
that a printing device can begin outputting printed material directly upon
receiving a print instruction.

BACKGROUND

Customer satisfaction with printing devices depends almost exclusively
on printing performance. Next to print quality, the speed with which a printing
device produces a document is perhaps the most important performance factor to
influence customer satisfaction. Most users composing a document on a
computer within an application program expect a printing device to begin
printing the document without delay once the user activates the “print” command
from within the application program. However, conventional methods of
processing document information prevent printing devices from outputting a
printed document directly upon user-activation of the print command. An
inherent delay exists that extends from the moment a user activates a print
20 command from within an application to the moment the printing device begins
moving print media to print a page. The larger and more data-intensive a
document is, the longer the delay will be. This delay reflects poorly on printing
performance and tends to reduce a user’s satisfaction with a printing device.

In general, documents are created or composed on a computer within an
application program in a “language” that the application understands. When a
25 user activates a print command within the application, printer driver software
associated with a printer normalizes the communication between the application

and the driver software so that the driver software can convert a document into a language that the printer understands. The language understood by the printer is a page description language (PDL) such as Printer Control Language (PCL) or PostScript.

5 Converting the application document from the application's language into the printer's language changes the document into a file often called a print job. Once the print job is created, it is transferred as streaming data to the associated printer. The print job is rendered into raster bits as it streams into the printer. The raster bits drive a print engine to lay down dots or pixels onto a print medium (e.g., a page of paper) in a pattern that matches the pattern of the document composed within the application program.

10 In addition to the inherent printing delay discussed above, there are other performance-related problems associated with current printing methods that can reduce a user's satisfaction with a printing device. Current printing methods do not process an application document for printing until a user activates a print command from within an application program. Activation of a print command typically occurs once a user has completely finished the document. Therefore, print jobs sent to printing devices tend to represent an entire document rather than just portions of a document. Depending on the size of a document, the
15 activation of a print command can place a sudden and extreme demand on printing resources. This sudden demand on printer resources can cause printing failures such as "memory out" and "page too complex" failures.

20 A "memory out" failure can occur as a print job is streaming into a printing device from, for example, a networked computer. A printer with a small
25 memory may run out of memory in the middle of processing a particularly large page of a print job. If this happens, the printer has no way to go back and execute techniques such as a data compression technique that might otherwise

permit the large page to be printed. Rather, the printer prints whatever portion of the page that it has processed from the streaming print job and then issues a “memory out” error.

A “page too complex” failure can occur if print job data streaming into the printer is not rendered fast enough as raster bits to keep up with the print engine. This type of failure relates in part to printer hardware speed and/or the speed of the network over which the print job is being transferred. Generally however, both the “memory out” failure and the “page too complex” failure relate to the sudden need for a printing device to process large amounts of data all at once.

Printer manufacturers try to alleviate the above problems using various techniques. For example, printer manufacturers introduce mechanisms into printing devices that lead a user to believe that there is little or no delay between the activation of a print command and the beginning of document printing by the printer. These mechanisms can include turning on printer lights or displaying a control panel message indicating the printer is warming up directly upon activation of a print command. Thus, users have a greater sense of satisfaction because they perceive that printers begin printing right when the print command is activated. However, these mechanisms only hide the processing delay inherent to current printing methods. They do not fix the delay.

In order to actually reduce the problems noted above that are associated with the sudden demands placed on printer resources, printer manufacturers continually introduce faster and more expensive hardware into succeeding generations of printing devices. Therefore, each new generation of printer tends to have faster and more expensive CPUs, data/instruction buses, memory, ASICs and the like. Printer manufacturers generally accept the notion that the fastest,

largest capacity and most costly components will be required to improve printer performance in succeeding generations of printing devices.

Accordingly, the need exists for a way to reduce printing delays and printing errors in printing devices without having to continually introduce faster, 5 larger capacity and more expensive components.

SUMMARY

A system and methods provide real-time printing that enables printing devices to begin outputting printed media directly upon activation of a print command. The system and methods generally perform preprocessing of a 10 printable document while the document is being created.

As a document is generated within an application program, a real-time print driver executes to continually process newly available document information. Each newly introduced piece of document information is 15 preprocessed as a fractional print job formatted in a page description language appropriate for an associated printing device. Fractional print jobs can be stored on the host computer or on the printing device after being rendered as raster data. When a user activates a print command from within the application program, the printing device begins printing the document directly from the preprocessed 20 stored document information.

In one embodiment, document information is converted into fractional print jobs that are transferred to an associated printing device. Fractional print jobs are rendered as raster bits that are stored in groups such as raster strips or raster patches. Each raster group represents part of a growing raster page. 25 Preprocessed raster pages stored on the printing device are printed on print media immediately upon activation of a print command. In this embodiment,

PRINTING SYSTEM

preprocessing includes converting document information into a page description language in addition to rendering the document information into raster data.

In another embodiment, document information is converted into fractional print jobs that are stored on the host computer. Each fractional print job represents a portion of a growing print job that is stored on the host computer. When a print command is activated, the print job is transferred to a printing device where it is rendered as raster data and printed. In this embodiment, preprocessing includes converting document information into a page description language and storing it on a host computer.

10 In both embodiments, an alteration to part of a document already preprocessed results in reprocessing only the part of the document that is altered. A fractional print job that includes the altered section of the document is processed as discussed in the above embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The same reference numbers are used throughout the drawings to reference like components and features.

20 **Fig. 1** illustrates a system environment that is suitable for real-time printing.

20 **Fig. 2** is a block diagram illustrating in greater detail, an exemplary embodiment of a host computer and printing device such as those shown in **Fig. 1**.

Fig. 3 is a flow diagram illustrating an example method of real-time printing.

25 **Fig. 4** is a flow diagram illustrating an alternate example method of real-time printing.

DETAILED DESCRIPTION

The system and methods described herein relate to printing a document in real-time. That is, upon activation of a print command, a printing device can immediately begin moving print media and output printed material. Rather than requiring printing resources to process a document all at once, the system and methods spread processing demands out over the duration of the document's composition. Advantages of the disclosed system and methods include reduced or nonexistent delay times between the activation of a print command and the initiation of printed output and a reduction in printing failures.

Exemplary System Environment For Real-Time Printing

Fig. 1 illustrates an exemplary system environment that is suitable for real-time printing. The exemplary system environment **100** of **Fig. 1** includes printing device **102** operatively coupled to a host computer **104** through a direct or network connection **106**. The direct or network connection **106** can include, for example, a printer cable, a LAN (local area networks), a WAN (wide area networks), an intranet, the Internet, or any other suitable communication link.

This disclosure is applicable to various types of printing devices **102** capable of rendering PDL (page description language) data in printed form on a print medium, such as printing pixels on paper. Therefore, printing device **102** can include devices such as laser-based printers, ink-based printers, dot matrix printers, dry medium printers, plotters and the like. In addition, printing device **102** can include various multi-function peripheral (MFP) devices that combine a printing function with other functions such as faxing, scanning, copying and the like.

Host computer **104** can be implemented as a variety of general purpose computing devices including, for example, a personal computer (PC), a server, a Web server, and other devices configured to communicate with printing device **102**. Host computer **104** typically provides a user with the ability to manipulate or otherwise prepare in electronic form, an image or document to be rendered as an image that is printed or otherwise formed onto a print medium by printing device **102** after transmission over network **106**. In general, host computer **104** outputs host data to printing device **102** in a driver format suitable for the device **102**, such as PCL or PostScript. Printing device **102** converts the host data and outputs it onto an appropriate recording media, such as paper or transparencies.

Exemplary System Embodiments For Real-Time Printing

Fig. 2 illustrates an exemplary embodiment of the system **100** in greater detail. Host computer **104** includes a processor **200**, a volatile memory **202** (i.e., RAM), and a non-volatile memory **204** (e.g., ROM, hard disk, floppy disk, CD-ROM, etc.). Nonvolatile memory **204** generally provides storage of computer readable instructions, data structures, program modules and other data for host computer **104**. Host computer **104** may implement various application programs **206** stored in memory **204** and executed on processor **200** that create a document or image (e.g., text and graphics) on a computer screen that is transferred to printing device **102** for creating a hard copy of the document/image. Such applications **206** might include software programs implementing word processors, illustrators, computer-aided design tools and the like.

Host computer **104** may also implement one or more software-based device drivers such as real-time driver **208** that are stored in non-volatile memory **204** and executed on processor **200**. Device drivers might also be implemented on the specific devices they are “driving”. In general, a device

driver such as real-time driver **208** formats document information into page description language (PDL) such as PostScript or Printer Control Language (PCL) or another appropriate format which it outputs to printing device **102**. In addition, real-time driver **208** operates in various ways to facilitate preprocessing of document information in preparation for document printing as discussed more specifically herein below.

Printing device **102** has a controller **210** that processes data from host computer **104**. The controller **210** typically includes a data processing unit or CPU **212**, a volatile memory **214** (i.e., RAM), and a nonvolatile memory **216**. Nonvolatile memory **216** can include various computer storage media such as ROM, flash memory, a hard disk, a removable floppy disk, a removable optical disk and the like. Nonvolatile memory **216** generally provides storage of computer readable instructions, data structures, program modules and other data for printing device **102**.

In the exemplary embodiment of **Fig. 2**, printing device **102** also includes a real-time collection module **218** stored in memory **216**. In general, real-time collection module **218** executes on processor **212** to format host computer **104** data and control the output of printing device **102** through printer device engine **220**. In addition, real-time collection module **218** operates in conjunction with real-time driver **208** in various ways that facilitate preprocessing of document information in preparation for document printing as discussed more specifically herein below.

In a first instance of the exemplary embodiment of **Fig. 2**, real-time driver **208** facilitates a dialogue between printing device **102** and an application **206** while a user actively composes a document within the application **206**. Real-time driver **208** converts or formats in real-time, each document event into a page description language (e.g., PostScript or Printer Control Language (PCL))

appropriate for a selected printing device 102. A document event includes any element that is newly introduced to a document as the document is composed within the application program 206. Therefore, a document event includes entering a character from a keyboard into a document, drawing a graphical mark 5 within a document, pasting a graphical object into a document, changing a font within a document, adding a background within a document and the like. In addition, a document event can include any manner of loading a file into an application 206. Thus, opening up a pre-existing document file stored in a memory or downloading a document file over a network into an application 206 10 are both examples of document events that initiate the formatting of document information into a page description language by real-time driver 208.

Each converted or formatted document event represents a small print job that is a fractional constituent of the document being generated within an application 206. In the first instance of the exemplary embodiment of **Fig. 2**, 15 real-time driver 208 transfers each fractional print job in real-time to printing device 102. A real-time collection module 218 receives each fractional print job and renders it into raster bits as a raster data package. Generally, raster bits drive a print engine to lay down dots or pixels onto a print medium (e.g., a page of paper) in a pattern that portrays a document composed within an application 20 program 206. A raster data bit represents one dot or pixel to be printed on a print medium. A raster data package typically represents some portion of a raster strip 20 or raster patch that includes many raster bits. Real-time collection module 218 stores raster data packages on printing device 102 as a growing raster page. As a document is being generated/composed within an application 206, real-time 25 collection module 218 can store numerous raster pages, each representing a page of the document.

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As indicated above, a document event includes any element that is newly introduced to a document as the document is composed within an application program 206. Therefore, document events that change during document composition are also processed in the same manner as described above by the 5 real-time driver 208 and real-time collection module 218. Processing a changed document event does not, however, require reprocessing portions of the document that have already been processed. Only the changed event itself must be reprocessed. For example, if the composer of a document finishes the last page of the document and then decides to go back and change the title page, the 10 real-time driver 208 and real-time collection module 218 process the changed document events as described above such that the appropriate raster bits are removed and/or altered.

When a user activates a print command from within an application 206, printing device 102 will immediately begin moving print media and printing 15 raster pages that have been preprocessed in the manner just described.

In a second instance of the exemplary embodiment of **Fig. 2**, real-time driver 208 facilitates a dialogue between printing device 102 and an application 206 while a user actively composes a document within the application 206. Just as in the first instance described above, real-time driver 208 converts in real- 20 time, each document event into a fractional print job formatted in a particular PDL appropriate for a selected printing device 102. Changes to document events are also handled in the same manner as described above.

In the second instance, real-time driver 208 stores each fractional print job 25 on host computer 104 as a portion of a growing print job. The growing print job represents in a PDL format, the entire document up to the latest document event that has been introduced within application 206. When a user activates a print command from within the application 206, real-time driver 208 immediately

begins transferring the print job to printing device **102** where the real-time collection module **218** renders it into raster data and begins printing raster pages onto a print medium.

5 **Exemplary Methods For Real-Time Printing**

Example methods for real-time printing will now be described with primary reference to **Figs. 3** and **4**. The methods apply generally to the exemplary embodiment of system **100** discussed above with reference to **Fig. 2**.

Figs. 3 and **4** are flow diagrams that show examples of general methods for real-time printing. At block **300** of **Fig. 3**, newly generated document information is converted into a fractional print job on a host computer **104**. The document information is typically generated from within an application program **206** executing on host computer **104**. At block **302**, the fractional print job is sent from the host computer **104** to a printing device **102**. At block **304**, the printing device **102** receives the fractional print job.

Upon receiving a fractional print job, printing device **102** renders the fractional print job to raster bits as shown in block **306**. At block **308**, printing device **102** stores the raster bits. Typically the raster bits are stored as raster data packages that eventually make up raster strips or raster patches. At block **310** a print command is received at host computer **104**. At block **312**, printing device **102** immediately begins printing stored raster data as raster pages onto a print medium.

Fig. 4 is a flow diagram illustrating an alternate example method of real-time printing. At block **400**, newly generated pieces of document information are converted into fractional print jobs on a host computer **104**. The document information is typically generated from within an application program **206** executing on host computer **104**. At block **402**, each fractional print job is stored

on host computer **104**. The fractional print jobs make up a growing print job being stored on host computer **104**. At block **404** a print command is received at host computer **104**. The print command is generated from within the application program **206**. At block **406**, the print job is sent to a printing device **102**.

5 Upon receiving the print job at block **408**, the printing device **102** renders it as raster bits at block **410**. The raster bits are printed as raster pages on a print medium at block **412**.

Although the description above uses language that is specific to structural features and/or methodological acts, it is to be understood that the invention defined in the appended claims is not limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the invention.

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